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TRIALS OF A RAPID CLAY ANALYSIS SYSTEM FOR COAL MINE STRATA

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TRIALS OF A RAPID CLAY ANALYSIS SYSTEM FOR COAL MINE STRATA

by

P. Cain*

ABSTRACT

It has been known for a longtime that the presence of swelling clays in coal mine strata can cause problems in the maintenance of underground openings. Unfortunately, the detection of these clays in rock samples is a costly and time consuming process involving the use of X-ray diffraction techniques and specialised sample preparation.

Recently, exploration geologists have had some success with a new, portable clay analysis package based on the intensity of two light wavelengths reflected from a sample surface.

This report describes trials with this equipment on rock samples from coal mines and a comparison of the results with clay analyses conducted by X-ray diffraction methods.

Although the comparison proved disappointing, the technique may be capable of modification to allow more accurate rapid analysis of clays in coal mine strata at a later date.

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ESSAIS D'UN SYSTÈME RAPIDE D'ANALYSE DES ARGILES DANS LES STRATES DES MINES DE CHARBON

par

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RÉSUMÉ

C'est un fait depuis longtemps connu que la présence d'argiles gonflantes dans les strates de mines de charbon peut causer des problèmes dans l'entretien des galeries souterraines. Malheureusement, la détection de ces argiles dans les échantillons de roches est coûteuse en temps et en argent, car il s'agit d'un processus impliquant des techniques de diffraction aux rayons X et d'une préparation spécialisée des échantillons.

Récemment, des géologues en exploration ont connu certains succès grâce à un nouvel ensemble portatif d'analyse des argiles, basé sur l'intensité de deux longueurs d'ondes lumineuses réfléchies par la surface d'un échantillon.

Le présent rapport décrit les essais effectués avec cet équipement sur des échantillons de roche provenant de mines de charbon et compare ces résultats avec ceux obtenus à partir d'analyses d'argile par la méthode de diffraction des rayons X.

Quoique la comparaison s'est avérée décevante, il y a tout lieu de croire que d'éventuelles modifications permettront, dans un proche avenir, des analyses plus précises et plus rapides des argiles dans les strates des mines de charbon.

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DISCLAIMER

The use of trade names in this report does not imply endorsement by CANMET.

INTRODUCTION

Swelling clays in coal mine rocks, particularly floor strata, can pose severe operational problems, especially in wet conditions. As the clay mineral lattice absorbs water it expands, causing mechanical deterioration of the strata, support penetration and excessive opening deformation. It is impossible to predict the occurrence of these conditions without knowing the clay mineral content of the strata concerned.

The most frequently used method of determining clay mineralogies in rock samples is that of X-ray diffractometry. Unfortunately, this is an expensive and time consuming process, requiring a well equipped laboratory and specialised sample preparation techniques.

The 'Claypak' portable clay analysis technique presented an opportunity to try to improve the ability of researchers to determine the clay mineralogy of coal mine rock samples more rapidly. The manufacturers of the 'Claypak' system, Barringer Research Limited, of Rexdale, Ontario, agreed to conduct trial analyses of rock samples from the Sydney Coalfield, Nova Scotia. In this report, the 'Claypak' system is described and the results of the 'Claypak' analyses compared to those conducted by X-ray diffraction methods.

THE 'CLAYPAK' PORTABLE CLAY ANALYSIS SYSTEM

The 'Claypak' portable clay mineral analysis system was developed by Barringer Research Limited from the hand-held ratioing radiometer (HHRR) which the company manufactures under licence from NASA's Jet Propulsion Laboratory. The HHRR was originally developed for 'ground truthing' remotely sensed data reported by NASA's Landsat satellites.

A radiometer measures the intensity of reflected radiation as a means of discriminating between visually similar objects. A ratioing

radiometer simultaneously analyses two bands in the spectrum and calculates the ratio of one to the other. This affords more positive identification of the material being analysed.

The 'Claypak' is a special version of Barringer's HHRR for use in precious metal exploration. In this environment, the presence of such clay minerals as kaolinite, illite, illite/smectite mixtures, chlorite, muscovite and biotite is an important indicator of the alteration haloes associated with many precious metal deposits. The 'Claypak' system has been successfully field tested for this use (Gladwell et al. 1983). The occurrence in coal mine rocks of many of the clay minerals successfully identified in precious metal deposit alteration haloes suggested that the 'Claypak' system might be appropriate for the rapid determination of clay mineralogies in coal strata. This would allow rapid prediction of trouble spots and give mine operators an ability to take preventive measures where required.

The principle of operation of the 'Claypak' system has been described by Gladwell (1982). In the past, the delineation of clay mineral haloes by remote reflectance techniques has relied chiefly on the use of the Al-O-OH absorption feature in the 2.2 micron region (Goetz et al. 1982), a wavelength not subjected to interference by atmospheric water. The 'Claypak' system uses the 2.65 - 2.82 micron region, overcoming any water vapour interference by using a shorter detection distance and an active light source. The use of this range of wavelengths also removes the interference effects of some commonly occurring minerals, e.g. calcite, gypsum and alunite.

The 'Claypak' system can identify five minerals: kaolinite, montmorillonite, muscovite, illite and chlorite. To do this, it calculates five different reflectance ratios. A computer programme is used to solve the five simultaneous equations that result from the solution algorithm (Gladwell 1982). The various clay mineral contents are presented as percentages.

The equipment making up the 'Claypak' system, the ratioing radiometer, the light source and the portable computer used for the analysis, are shown in Plate 1.

Plate 1 - The 'Claypak' system showing the radiometer (blue), light source (black) and the computer (Photograph courtesy of Barringer Research Ltd.)

TEST PROGRAMME

TEST METHOD

Two samples of coal mine strata were sent to Barringer Research for analysis using the 'Claypak' technique. Each sample was crushed and pulverised. After screening to obtain the -80 +200 mesh fraction, the samples were then split to give a larger number of sub-samples to test. Samples of the rocks sent to Barringer were also analysed using conventional X-ray diffraction techniques by Corelabs at their Calgary laboratory (Forgeron 1985).

RESULTS

The results obtained from the two different test methods are shown in Tables 1 and 2 below.

Table 1 - Clay mineral contents obtained by the 'Claypak' method

Sample	Sub-sample	K/B	I/Sm	Chl	Mo	I/Mu
	1	17	62	1	-	-
	2	9	72	2	-	-
	3	17	-	1	-	3
	4	9	-	4	65	-
A	5	22	54	1	-	-
	6	17	56	2	-	-
	7	8	64	4	-	-
	8	17		1		3
		--	--	--	--	--
Average, Sample A		14	38	2	8	1
	1	3	-	15	55	-
	2	14	-	8	37	-
B	3	7	-	2	-	14
	4	14	46	5	-	-
		--	--	--	--	--
Average, Sample B		10	12	8	23	4

Table 2 - Mineral contents obtained by X-ray diffractometry

Mineral	Sample A (%)	Sample B (%)
Kaolinite	9	4
Illite	47	35
Chlorite	8	5
Smectite	nil	nil
Muscovite	tr*	tr
Pyrite	tr	tr
Feldspar	1	1
Quartz	35	55
	---	---
TOTAL	100	100

*tr = trace

The outstanding feature of the results is the lack of correlation. Only in the analysis of chlorite did the 'Claypak' system come close to the results of the X-ray diffraction results. The reasons for this are discussed below.

DISCUSSION

The 'Claypak' system is based on the characterisitc reflectance of pure clay mineral standards. However, coal measures strata can contain a high percentage of mixed layer clays, which have different, poorly documented, reflectance characteristics. Gladwell (1982) pointed out that further research is needed into mixed layer clays if the 'Claypak' technique is to be accurate in their analysis.

A further possible cause for the analytical discrepancy is the difference between X-ray and reflectometer analysis. X-ray analysis is penetrative, whilst reflectometer analysis represents only the surface under examination. Clay mineral coating or quartz/feldspar grains obtained during preparation would result in the high clay content values obtained.

Subsequent to the testing programme described above, Barringer Research developed different algorithms to tackle smaller portions of a clay mineral discrimination attempt; pyrophyllite and kaolinite are being successfully discriminated from themselves and other clays by a mining company in Ontario using the 'Claypak' system (Lawrence 1986).

CONCLUSIONS AND RECOMMENDATIONS

The initial test programme described above showed that the results obtained by conventional X-ray diffractometry and those obtained using the radiometer were substantially different.

Developments in 'Claypak' technology since these initial tests and a programme of research into the reflectance characteristics of mixed layer clays common to coal mine strata generally or coal mine strata from a particular region may enable more accurate determinations to be made.

Recent research (CANMET 1986), indicates that coal measure floor strata from the Sydney Coalfield show little propensity to swell. The recommended research must therefore be given low priority as far as short to medium-term research in the Sydney Coalfield is concerned.

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